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DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources - Native Aquatic Species

COLUMBIA SPOTTED FROG
(*Rana luteiventris*)

CONSERVATION AGREEMENT AND STRATEGY

ANNUAL PROGRESS REPORT: 2000

Publication Number 01-12
Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, Utah
John F. Kimball, Director

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Final Report
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INTRODUCTION

Columbia spotted frog (*Rana luteiventris*) is classified as a Utah Sensitive Species (Utah Division of Wildlife Resources 1997a) due to declines in population sizes and distribution. In Utah, historic Columbia spotted frog (spotted frog) distribution included areas within the Bonneville Basin along the Wasatch Front and in the West Desert (Table 1, Figure 1). Museum records and anecdotal information for the Wasatch Front suggest that spotted frog occurred historically in the Upper Weber River, Utah Lake, Spanish Fork River, Provo River, Jordan River, and San Pitch River drainages (Toone 1991, Turner 1960, Tanner 1931). In the West Desert, spotted frog occurred historically in several spring complexes in Snake Valley, Tule Valley, and Ibapah Valley. Currently, spotted frog populations persist in all of these areas except for the Upper Weber River and Jordan River drainages. However, the number of populations in most of these areas has diminished, and many of the extant populations, particularly those along the Wasatch Front, are small due to recent population declines. The declines have been attributed to urbanization, water development projects, livestock grazing, and the introduction and proliferation of nonnative species.

The Spotted Frog Conservation Agreement and Strategy (SFCAS; Perkins and Lentsch 1998a) was developed in 1998 as a collaborative and cooperative effort among resource agencies to expedite the implementation of conservation actions for spotted frog. The goal of the SFCAS is to ensure the long-term persistence of the species by eliminating or significantly reducing threats and restoring populations throughout the historic range. To achieve this goal, nine classes of required actions are described in the SFCAS, including: 1) surveys; 2) genetic analysis; 3) research; 4) habitat protection and enhancement; 5) nonnative species control; 6) range expansion; 7) population monitoring; 8) mitigation; and 9) regulation.

The SFCAS requires annual assessments of actions that are implemented for the conservation of spotted frog. This progress report fulfills this requirement for calendar year 2000. The report is organized according to the four Geographic Management Units (GMUs) and associated subunits (U.S. Geological Survey 1974) that were defined in the SFCAS (Table 1, Figure 1). Descriptions of the unit, conservation actions, status of threats, and population trends are provided for each GMU. An assessment of progress follows, and the report concludes with a description of future actions.

WASATCH FRONT GEOGRAPHIC MANAGEMENT UNIT

GMU Description

Six subunits comprise the Wasatch Front GMU (Table 1, Figure 1). Historic records suggest that spotted frog occurred in the Upper Weber River, Utah Lake, Spanish Fork River, Provo River, and Jordan River subunits. Currently, one population occurs in the Utah Lake subunit (Mona/Burraston), two populations occur in the Spanish Fork River subunit (Springville/T-bone Bottoms and Holladay Spring), and two populations occur in the Provo River subunit (Heber Valley and Jordanelle/Francis) (Table 1, Figure 1). Major threats to spotted frog throughout this GMU include urbanization, water development, livestock impacts, and detrimental interactions with nonnative species.

Conservation Actions

Surveys:

Surveys are required in all subunits. In 1998 and 1999, surveys were conducted in the Upper Weber River, Lower Weber River, Utah Lake, Spanish Fork River, and Provo River subunits (Thompson 2000, Thompson 1999, Wilson and Balcombe 1999). No additional surveys were conducted in 2000.

Research:

The SFCAS requires research to determine spotted frog habitat and life-history requirements. Prior to the development of the SFCAS, Perkins and Lentsch (1998b) completed a study of habitat use in Heber Valley. University of Nevada Reno (UNR) and UDWR also initiated research efforts along the Provo River in Heber Valley. Research continued in 2000:

UNR and UDWR characterized spotted frog use of wetlands for breeding in Heber Valley according to permanence, hydrology, and wetland type. A summary of preliminary results is provided in Ammon and Wilson (2000).

UDWR and UNR continued a spotted frog movement study in Heber Valley. To track movements among wetlands, spotted frogs have been captured in pitfall traps and subsequently marked with Passive Integrated Transponder tags. By fall 2000, 439 frogs had been tagged and 97 of the tagged frogs had been recaptured. Ninety-four percent of the recaptured frogs were caught in the site of their original capture. A summary of this ongoing effort is provided in Ammon and Wilson (2000).

UDWR initiated a study to determine if spotted frogs can be identified by individual spotting patterns. Study organisms were obtained when tadpoles found in one Heber Valley wetland were taken into captivity in September 2000. Metamorphosis of these tadpoles had not yet occurred due to unusually cold water in this wetland, and the tadpoles would not have survived the winter. The purpose of obtaining the tadpoles was to record the spotting patterns on individual frogs from metamorphosis to adulthood. If the spotting pattern on each frog remains consistent throughout its life, then it will be possible to identify individual frogs in natural habitats without invasive and potentially harmful marking or tagging. Each frog was held in a separate tank and photographed at regular intervals to record spotting patterns. This effort will continue through 2001. Each wild frog that was tagged in association with the movement study was also photographed after each capture. If the results of the study suggest that spotting patterns remain consistent, the photographs of the wild frogs may be useful to test the efficacy of using spotting patterns to identify frogs in the field.

UNR and UDWR conducted an experimental translocation of spotted frog egg masses in Heber Valley. The source sites for the egg masses were two ponds that were scheduled to be impacted by Provo River Restoration Project (PRRP) construction. To prevent the loss of these egg masses and to evaluate a translocation method, 34 egg masses were moved into two sites in the middle section of the Provo River.

Prior to this translocation, spotted frogs had not been detected within two kilometers of the sites, and given the unlikely probability that spotted frogs would colonize the sites naturally, any subsequent presence of spotted frogs would indicate that the translocation had been successful. Despite a substantial flood that occurred after the egg masses were transferred, tadpoles were observed in the translocation sites in May. Metamorphs were observed in August, and juvenile spotted frogs from the 2000 year class were observed at both sites on subsequent visits.

Habitat Protection and Enhancement:

Habitat protection and enhancement projects are required in all subunits. To date, habitat projects have been implemented in the Utah Lake and Provo River subunits:

In 1998, the Utah Reclamation Mitigation and Conservation Commission (URMCC) and UDWR acquired a portion of the Mona spring complex and associated property (34.5 hectares) in the Utah Lake subunit to protect three Utah Sensitive Species, including spotted frog, least chub (*Iotichthys phlegethontis*), and California floater (*Anodonta californiensis*). This acquisition protected these species from the rapid development occurring along the Wasatch Front. At the time of the acquisition, however, the Mona spring complex had already been severely degraded by livestock (Figure 2, Figure 3). In 2000, UDWR implemented habitat enhancement actions on the property to: 1) improve riparian conditions; 2) slow spring succession; and 3) improve water quality. The fence surrounding the property was repaired to prevent livestock access outside of the permitted grazing period (as part of the purchase agreement, livestock are permitted on the property between May and November until 2004). To prevent direct livestock access to spotted frog habitat, a two-strand electric fence was constructed around the spring complex on the property. UDWR removed all cow carcasses and manure from the electric fence interior. In addition, UDWR continued negotiations to acquire additional properties surrounding the currently unprotected portion of the Mona spring complex. Acquisition of two additional land parcels (16.2 hectares) would enable UDWR to protect and enhance habitat throughout the entire spring complex.

In 1999, URMCC created 22 new wetlands along the Provo River between Jordanelle Dam and Deer Creek Reservoir as part of the PRRP pilot project. These wetlands were constructed to provide and enhance spotted frog habitat and to mitigate for impacts that would occur in association with other PRRP actions. In 2000, URMCC and the U.S. Bureau of Reclamation (BOR) maintained these wetlands. Ten of the 22 wetlands contained egg masses in spring 2000 (Table 2), indicating that spotted frogs are using the ponds for breeding. Thirty-eight of the 167 aquatic sites in Heber Valley are currently occupied by spotted frog. These 38 sites cover 16.8 hectares and comprise 35 percent of the total wetland area in the Provo River corridor (Ammon and Wilson 2000).

URMCC completed additional land acquisitions in the Provo River subunit in conjunction with PRRP. In 1998 and 1999, URMCC acquired 82.1 hectares that contain wetlands that are either occupied by spotted frog or that represent potential spotted frog habitat. The acquisition of these lands protects spotted frog habitat from development along the Provo River corridor. In 2000, URMCC acquired an additional 78.9 hectares acres of land for this purpose.

Nonnative Species Control:

Control of nonnative species is required in all subunits. Prior to 2000, limited nonnative species control efforts were implemented in the Mona spring complex in the Utah Lake subunit (Wilson and Thompson 1999). Funded by BOR, UDWR conducted a more extensive nonnative fish removal project at the Mona spring complex in fall 2000. Prior to this project, mosquitofish (*Gambusia affinis*) and several other nonnative fish species were abundant throughout the spring complex. The objectives of the project were to: 1) eliminate or significantly reduce threats posed by nonnative fishes; 2) evaluate mechanical trapping as a technique to control nonnative fishes; and 3) monitor spotted frog and least chub population responses. To remove nonnative fishes, approximately 400 minnow traps were set daily for 19 nights. Fish were identified and enumerated and nonnative fishes were removed from the spring complex. A total of 41,054 fish were

captured. Nonnative fishes comprised 90 percent (n = 36,968) of the catch. Mosquitofish comprised 61 percent (n = 25,080) of all captured nonnative fishes. Monitoring will be conducted in 2001 to determine how quickly nonnative fish re-populate the spring complex and to assess the response of the native species populations. The removal effort will likely be repeated in fall 2001.

Range Expansion:

Range expansion actions are required in all subunits. Limited range expansion has occurred in Heber Valley in the Provo River subunit because spotted frogs have colonized a portion of the wetlands that were created in 1999. In addition, an experimental translocation was conducted in Heber Valley along the Provo River. No other frog transfers have occurred to date. Statewide range expansion actions are discussed in a subsequent section.

Population Monitoring:

The SFCAS requires annual monitoring of all spotted frog populations in the Wasatch Front GMU. UDWR began annual monitoring in 1992 and continued this effort in 2000. Methodology and results are described in Wilson and Balcombe (2000). Monitoring data are presented in Figures 5, 6, and 7. Additional monitoring has also been conducted in Heber Valley every year since 1994, in conjunction with ongoing research efforts in this area (Ammon and Wilson 2000).

Status of Threats

Prior to the development of the SFCAS, potential residential development threatened the Mona/Burraston population. Due to the purchase of property surrounding a portion of the Mona spring complex, this threat has been reduced significantly. Livestock grazing was another threat to habitat in the Mona spring complex. Banks were severely trampled and riparian vegetation was scarce. Livestock trampling had also accelerated spring succession. Cow carcasses and manure were abundant in and around the spring complex, potentially compromising water quality. The impacts to spotted frog may have included tadpole and adult mortality due to direct trampling, slower growth rates caused by a diminished prey base, and a decrease in reproductive success due to alteration of water temperature, water chemistry, and habitat structure (Reaser 1996). Since the implementation of the SFCAS, livestock impacts have been significantly reduced and habitat conditions have significantly improved in the protected area of the spring complex. The banks no longer exhibit evidence of livestock trampling and the riparian vegetation has returned (Figure 2, Figure 3). Spring succession is no longer accelerated. Water quality has been improved by the removal of excess nutrients previously provided by livestock. However, habitats in other unprotected areas of the spring complex are still threatened by livestock and accelerated spring succession.

Nonnative fish also pose a threat in the Mona spring complex. Nonnative fish at the site include: mosquitofish, rainwater killifish (*Lucania parva*), plains killifish (*Fundulus zebrinus*), fathead minnow (*Pimephales promelas*), common carp (*Cyprinus carpio*), and green sunfish (*Lepomis cyanellus*). Mosquitofish is a particular threat to spotted frog, because it is a known predator on amphibian eggs and larvae (Grubb 1972) and it may selectively prey on amphibians despite the availability of other potential prey items (Goodsell and Kats 1999). In a study by Lawler et al. (1999), red-legged frog (*Rana aurora*) tadpoles suffered more injuries in ponds containing mosquitofish, and weighed 34 percent less at metamorphosis compared to tadpoles in fishless ponds. Mosquitofish may cause similar impacts to spotted frog in the Mona spring complex. The threats posed by mosquitofish and other nonnative fishes have been reduced through the mechanical removal project conducted in fall 2000. Monitoring will be conducted to determine how quickly nonnative fishes will re-populate the complex and to assess the response of native populations. It is probable that it will be necessary to repeat the removal effort regularly to maintain nonnative fish populations in low numbers.
A potential future threat to the Mona/Burraston population is groundwater withdrawal is north Juab Valley. A simulation by Thiros (1999) suggested that, at 1992 rates of withdrawal, groundwater levels near this population would be lowered by approximately five feet and groundwater discharge rates would experience a 38 percent reduction by 2022. Withdrawals that exceed the 1992 rate would further deplete groundwater

levels and rates of discharge. Therefore, water withdrawals may decrease the size of available spring habitat in north Juab Valley.

The threats to spotted frog populations in the Spanish Fork River subunit include urbanization, low water levels, and livestock impacts. Both the Springville/T-bone Bottoms and Holladay Spring populations occur in areas that are experiencing rapid residential development. The Springville habitat occurs on property owned by UDWR, and therefore experiences some degree of protection. The T-bone Bottoms and Holladay Spring sites, however, are on private lands and are subject to impacts from potential development. Water levels decline throughout the breeding season in the T-bone Bottoms and Holladay Spring habitats, subjecting egg masses to potential desiccation, or potentially causing habitats to dry prior to tadpole metamorphosis. The T-bone Bottoms population also experiences livestock impacts similar to those that were previously occurring at the Mona spring complex. Funds have been secured to develop a habitat management plan for the Spanish Fork River subunit to identify strategies to eliminate these threats and to improve spotted frog habitat. UDWR will initiate plan development in 2001.

Spotted frog populations in the Provo River subunit were threatened by loss of habitat due to residential development and water development projects. Through habitat acquisitions associated with PRRP, the threat to spotted frog posed by residential development has been significantly reduced. The construction of 22 new wetlands has also significantly increased the amount of suitable spotted frog habitat along the Provo River corridor. Although some modification in wetland maintenance and irrigation practices may be necessary, URMCC and BOR have committed to provide sufficient water to these wetlands during the spotted frog breeding season. Habitats not yet acquired are still threatened by residential development, and further efforts are necessary to secure these areas.

Rapid urbanization, agricultural practices, water development projects, and nonnative species continue to impact historic habitats elsewhere in the Wasatch Front GMU. Residential developments continue to expand into historically occupied areas. Livestock use has degraded wetlands within the historic distribution. The diversion of springs and streams, the pumping of groundwater, and inundation of reservoirs have altered natural flows, depleted groundwater discharges, and rendered many areas unsuitable for spotted frog. These practices have also fragmented historic habitats, limiting, if not eliminating, opportunities for natural re-colonization. Groundwater level declines due to withdrawal for human use, similar to those predicted for north Juab Valley, will likely occur in other areas as well. Several nonnative species that occur in the Mona spring complex have also been introduced into other historic spotted frog habitats. Other species that are potential spotted frog predators, including, but not limited to, rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), largemouth bass (*Micropterus salmoides*), white bass (*Morone chrysops*), and walleye (*Stizostedion vitreum*), have been introduced into areas within the historic spotted frog distribution. Removal efforts would be necessary prior to the re-introduction of spotted frog into areas where these species occur.

Population Trends

Population trends are assessed in terms of observed egg mass numbers at standard monitoring sites. Egg mass data for recently discovered breeding sites are provided, but remain separate from the standard site data to allow comparisons among years. The Mona/Burraston population has been monitored since 1992 (Figure 5). Fifteen egg masses were observed at standard monitoring sites during the first year of monitoring. The number of observed egg masses declined to only five in 1994 and then surged to as high as 148 in 1997. The number of observed egg masses at standard monitoring sites declined to 78 in 1998 and 61 in 1999, and then increased once again to 111 in 2000. Therefore, the number of egg masses observed for this population in 2000 is more than seven times greater than it was in 1992 when monitoring began. Additional breeding sites were discovered in 1999, and the total number of egg masses observed for this population in 2000 was 120. It is also important to note that several conservation actions have been recently implemented in the Mona spring complex and there will likely be a time lag between implementation and an observable positive population response. Therefore, it is anticipated that the numbers of egg masses observed annually will continue to exhibit a generally increasing trend.

The populations in the Spanish Fork River subunit have also been monitored since 1992 (Figure 6). The number of egg masses at the Springville/T-bone Bottoms site was 12 in 1992, and increased to as high as 87 in 1998. Fifty egg masses were observed at the Springville site in 2000. The T-bone Bottoms area was not monitored. The number of egg masses observed at the Holladay Spring site was 36 in 1992, increased to as high as 144 in 1999, and was 135 in 2000 at standard monitoring sites. The egg mass data indicate that reproductive output for both populations in this subunit have increased since monitoring began. Additional breeding sites were discovered near Holladay Spring in 1999, and the egg mass totals for 1999 and 2000 are 192 and 160, respectively. It is probable that surveys conducted in 2001 and 2002 to develop a habitat management plan for this subunit will discover additional breeding sites and egg masses.

The Heber Valley population in the Provo River subunit is the largest population in the Wasatch Front GMU (Figure 7). In 1992, 272 egg masses were observed. The smallest number of egg masses (n = 89) was observed in the following year. In 1997, 483 egg masses were observed, representing the largest reproductive output since monitoring began. In 2000, there were 409 observed egg masses. These data suggest that the reproductive output increased significantly from 1992 to 1997, and has since been generally stable. The number of observed egg masses at the Jordanelle/Francis site increased from 63 to as high as 93 from 1992 to 1994, and then declined to as few as 20 in 1999. In 2000, the number of egg masses observed at standard monitoring sites rebounded to 59. These data indicate that this population has been generally stable since monitoring began. Additional breeding sites were also found at the Jordanelle/Francis site. These additional sites produced 43 and 40 egg masses, in 1999 and 2000, respectively. The total number of egg masses observed at this site in 2000 was 99.

WEST DESERT GEOGRAPHIC MANAGEMENT UNIT

GMU Description

The West Desert GMU includes nine subunits (Table 1, Figure 1). Historic records suggest that spotted frog occurred in the Snake Valley, Tule Valley, and Ibapah Valley subunits. Extant spotted frog populations are currently found in Miller Spring/Leland Harris Springs, Gandy Salt Marsh, and Bishop Springs in the Snake Valley subunit, in Coyote Springs, Willow Springs, North Tule Springs, and South Tule Springs in the Tule Valley subunit, and in Ibapah Valley in the Ibapah Valley subunit (Table 1, Figure 1). Major threats to spotted frog in this GMU include water diversion, livestock grazing, nonnative species, and proposed gas and oil exploration.

Conservation Actions

Surveys:

The SFCAS requires additional surveys in all subunits. In 1998 and 1999, surveys were conducted in the Snake Valley, Tule Valley (Hogrefe and Fridell 2000), and West Great Salt Lake (Thompson 1999) subunits. In 2000, UDWR surveyed numerous wetlands in Box Elder County in the West Great Salt Lake subunit. Although the primary focus of the surveys was to define boreal toad (*Bufo boreas boreas*) distribution, data were collected for all observed amphibians. No spotted frogs were observed.

Habitat Protection and Enhancement:

Habitat enhancement is required in the Snake Valley, Tule Valley, and Ibapah Valley subunits. To date, habitat projects have been implemented in the Snake Valley subunit. In 1998, the U.S. Fish and Wildlife Service (FWS), UDWR, and a private landowner developed an agreement to improve habitat conditions at Miller Spring. This site supports one of the largest spotted frog populations, but it had been degraded due

to livestock impacts and sedimentation associated with road run-off. The objectives of this agreement were to: 1) eliminate livestock impacts at Miller Spring; 2) increase suitable habitat area; and 3) reduce livestock impacts in the associated wetlands. In 1999, the spring was dredged, the dike was repaired, and culverts were installed to create more open water. Additionally, the process of dividing 76 hectares into four pastures to implement a rotational grazing system was initiated in 1999. In 2000, a fence surrounding Miller Spring was constructed to exclude livestock (Figure 4) and fence construction for the four pastures continued. Completion of the fencing is anticipated for 2001.

Nonnative Species Control:

The SFCAS requires nonnative species control in the Snake Valley, Tule Valley, Tooele Valley, Skull Valley, Ibapah Valley, West Great Salt Lake, and North Great Salt Lake subunits. In 1999, rainbow trout were removed from Miller Spring. No other control projects designed to directly benefit spotted frog have been implemented to date. However, several rotenone treatments have been conducted on the Fish Springs National Wildlife Refuge in the Ibapah Valley subunit to eradicate mosquitofish and provide suitable sites for least chub re-introduction (Wilson 1999). In 2000, preparations were made to remove mosquitofish from Percy Spring and House Spring on the refuge. The outflow of Percy Spring was moved downstream to connect with an adjacent pond. The adjacent pond contained mosquitofish and provided a source for re-colonization after Percy Spring had previously been treated with rotenone. When additional removal projects are conducted, Percy Spring and the adjacent pond will be treated as one water body, and the probability of mosquitofish re-colonization will be reduced. Additionally, a second diversion structure was constructed at the outflow of House Spring to prevent re-colonization of mosquitofish following future removal projects. After mosquitofish are eradicated, these springs may represent suitable potential habitat for both least chub and spotted frog.

Range Expansion:

Range expansion actions are required in the Snake Valley, Tule Valley, and Ibapah Valley subunits. No localized actions have been implemented to date. Statewide range expansion actions are discussed in a subsequent section.

Population Monitoring:

The SFCAS requires annual monitoring of all spotted frog populations in the West Desert GMU. UDWR has monitored the Snake Valley populations, the Tule Valley populations, and the Ibapah Valley population since 1993. Methodology and results are described in Fridell et al. (2001) and Wilson and Balcombe (2000). Monitoring data are presented in Figures 8, 9, and 10.

Status of Threats

Prior to the development of the SFCAS, the Miller Spring population in Snake Valley was threatened by livestock impacts, spring succession, and nonnative species. Little open water was available in Miller Spring due to sedimentation and trampling associated with livestock use. Other livestock impacts included bank trampling and potential degradation of water quality. Predation by rainbow trout was also a threat. Since the enhancements were implemented, the conditions at Miller Spring have improved significantly (Figure 4). There is now several times more open water area due to dredging and dike repair. Due to the exclusion of livestock, the banks no longer exhibit evidence of trampling, the riparian vegetation has returned, and water quality is no longer threatened by excess nutrients. Rainbow trout have not been observed in the spring in two years and there is no longer a threat of predation. Maintenance of the livestock exclosures in Gandy Salt Marsh constructed by the U.S. Bureau of Land Management (BLM) in 1990 and 1995 have also protected spotted frog from livestock impacts.

Some habitats in Snake Valley, however, continue to be threatened by several factors. A large portion of Bishop Springs is regularly de-watered during the summer because the water source for a portion of the

marsh is diverted for irrigation. This water diversion is considered to be the most serious threat to spotted frog in this GMU. Livestock also continue to degrade spotted frog habitats in Bishop Springs and portions of Leland Harris Springs. Nonnative species, including largemouth bass, common carp, and bullfrog (*Rana catesbeiana*), occupy portions of Bishop Springs and are potentially impacting spotted frog. Northern leopard frogs (*Rana pipiens*) are abundant in Gandy Salt Marsh, but any detrimental impacts due to competition are unknown at this time. Proposed gas and oil exploration remains a threat in Snake Valley.
Threats to spotted frog in the Tule Valley subunit include livestock impacts and spring succession. To reduce livestock impacts, BLM constructed livestock exclosures around several springs in 1990 and 1991. In areas where exclosures are not in place, livestock impacts, including eroded banks and intensively grazed, trampled vegetation, range from low to severe (Fridell et al. 2000, Hogrefe and Fridell 2000). Puncture holes caused by livestock have also been observed at many of the Tule Valley spring sites (Hovingh 1993). These holes allow water to drain into the ground, thereby decreasing the size of the wetland habitats. The majority of springs in Tule Valley possess shallow water and dense vegetation (e.g. *Scirpus spp.*) and little breeding habitat is available due to the lack of open water. Succession is evident in most of the springs, but the vegetative congestion is most pronounced in the springs from which livestock have been excluded. It is possible that livestock grazing has prevented that degree of congestion in the springs without fencing. A mechanism that is less harmful than livestock grazing should be identified and used to slow spring succession and increase suitable spotted frog habitat. The Tule Valley springs contain no fish or other amphibian species. Therefore, competition or predation poses no threat.

The majority of the Ibapah Valley population occurs in Nevada and a smaller portion extends into Utah. Until recently, the Utah segment of this population faced only minor threats from livestock impacts. In 2000, however, a large portion of the breeding habitat was dry. The population relies on irrigation to inundate breeding habitats. In 2000, irrigation was delayed and many habitats lacked water until late in the breeding season. To prevent this delay from occurring again, it will be necessary to secure water for these sites by developing an agreement with the landowner.

In other potential habitats within this GMU, threats include habitat degradation and nonnative species. Although urbanization poses little threat, agricultural practices, including water diversion and livestock grazing, have degraded other wetland habitats. The presence of nonnative fishes, including, but not limited to, largemouth bass, rainbow trout, and mosquitofish, has also rendered many potential introduction sites unsuitable for spotted frog.

Population Trends

Monitoring of the populations in the Snake Valley subunit has been conducted since 1993 (Figure 8). The number of egg masses observed at Miller Spring/Leland Harris Springs each year has increased significantly in that time. However, monitoring sites were adjusted in 1998 and therefore, post-1997 data may not be comparable to those for earlier years. The number of egg masses was 739 in 1993, as high as 1,291 in 1996, and was 910 in 1997. When the monitoring sites changed in 1998, the number of egg masses observed was 2,154. In 2000, 1887 egg masses were observed. Although large fluctuations have occurred at Gandy Salt Marsh, the number of egg masses observed in 1993 and 2000 are similar. The number of egg masses observed was 707 during the first year of monitoring, rose to as high as 1,545 in 1998, and then declined to 784 by 2000. The number of egg masses observed recently at Bishop Springs is significantly lower than it was in 1993, but reproductive output has been stable for three years. In 1993, 1,252 egg masses were observed. By 1998, this number had declined to 275. In 2000, 241 egg masses were observed.

The four populations in Tule Valley have been monitored since 1993 (Figure 9). The number of egg masses observed at Coyote Springs has increased in that time. In 1993, 502 egg masses were observed. In 1999 and 2000, the numbers of observed egg masses were 651 and 950, respectively. Since 1993, the Willow Springs reproductive output has been generally stable. The numbers of egg masses observed in 1993, 1999, and 2000 were 129, 112, and 108, respectively. The numbers of egg masses observed at North Tule Springs was 904 in 1993, 330 in 1997, 441 in 1998, 328 in 1999, and 573 in 2000. Eighty-one and 72 egg masses were observed in South Tule Spring in 1993 and 1999, respectively. No egg masses were observed at this

site in 2000.

The Ibapah Valley population was stable between 1993 and 1997 when the numbers of egg masses observed were 2,195 and 2,321, respectively (Figure 10). The monitoring sites were adjusted in 1998 and subsequent data are not comparable to earlier years. The numbers of egg masses observed in 1998, 1999, and 2000 were 440, 621, and 327, respectively. In 2000, a large area of the breeding habitat did not contain water until late in the season due to modified water diversion practices. The relatively low number of egg masses observed in 2000 can likely be attributed lack of suitable breeding habitat due to this lack of water.

SEVIER RIVER GEOGRAPHIC MANAGEMENT UNIT

GMU Description

Nine subunits comprise the Sevier River GMU (Table 1, Figure 1). Historic records suggest that spotted frog occurred in the San Pitch River subunit. Currently, a single population occurs in this subunit near the town of Fairview (Table 1, Figure 1) and represents the only known population in this GMU. Major threats to spotted frog include livestock impacts, water development projects, and detrimental interactions with nonnative species.

Conservation Actions

Surveys:

Surveys are required in all subunits. Prior to 2000, surveys were conducted in the Lower Sevier River subunit (Richards 1997) and the San Pitch River subunit (Wilson and Balcombe 2000). In 2000, additional surveys were conducted in the same subunits:

- UDWR surveyed 81.6 square kilometers of wetlands between Mount Pleasant and Milburn in the San Pitch River subunit. Ninety-nine spotted frog egg masses were observed at 14 previously unknown breeding sites. These surveys were funded by FWS.

- UDWR surveyed all suitable wetland habitat in Mills Valley in the Lower Sevier River subunit. No spotted frogs were observed.

Habitat Protection and Enhancement:

The SFCAS requires habitat projects in the San Pitch River subunit. In 1999, FWS funded UDWR to develop a strategy for spotted frog habitat protection and enhancement in this subunit. At the time, the known spotted frog distribution was limited to a few sites near the town of Fairview. Monitoring data indicated a small and declining population. These habitats were threatened by livestock impacts, agricultural practices, and nonnative species. As the initial step to develop the strategy, UDWR conducted surveys in 1999 and 2000 to delineate occupied and potential spotted frog habitats. Survey data and wetland boundaries were mapped to assess connectivity among habitats and to identify important dispersal corridors. Private land boundaries were also mapped to identify areas where conservation easements may be necessary to protect and enhance spotted frog habitat. In 2000, UDWR developed a draft habitat management plan for the San Pitch River subunit (Wilson and Balcombe 2001). The plan includes a description of the current spotted frog distribution, habitat parameters, threats, and recommended conservation actions at each site. Conservation actions outlined in the plan include the purchase of conservation easements on private property, physical modification of wetlands to create more suitable habitat conditions, fencing of riparian areas to exclude livestock, and control of nonnative species. The habitat management plan will be finalized in 2001. Funding has already been secured to partially implement this plan.

Nonnative Species Control:

Nonnative species control is required in all subunits. Nonnative species control projects have not yet been implemented.

Range Expansion:

Range expansion actions are required in the San Pitch River subunit. Localized range expansion actions have not yet been implemented. Statewide range expansion actions are discussed in a subsequent section.

Population Monitoring:

The SFCAS requires annual monitoring of all populations in the Sevier River GMU. UDWR began monitoring of the San Pitch River population in 1992 and continued this effort in 2000. Methodology and results are described in Wilson and Balcombe (2000). Monitoring data are presented in Figure 11.

Status of Threats

The San Pitch River population is currently threatened by livestock impacts, nonnative species, and the risk of residential development. Livestock impacts include bank trampling, reduction of riparian vegetation, and degradation of water quality. Nonnative aquatic species, including rainbow trout and common carp, also occupy several wetlands in this subunit, and are potentially impacting spotted frog. Nonnative raccoons (*Procyon lotor*) are known predators on amphibians (MacDonald 1884) and are abundant in the San Pitch River subunit. However, the extent of the threat posed by raccoons is unknown at this time. Nineteen of 26 breeding sites in this subunit occur on private property (Wilson and Balcombe 2001). For this reason, residential development in or near these habitats continues to be a possibility. The habitat management plan for the San Pitch River subunit (Wilson and Balcombe 2001) describes conservation actions to reduce these threats in each current and potential spotted frog habitat. As this plan is implemented, beginning in 2001, these habitats will be protected and improved to the benefit of spotted frog. Funding has already been secured for certain actions, which include the purchase of conservation easements, nonnative species control, and livestock fencing.

Urbanization, agricultural practices, water development projects, and nonnative species continue to impact potential habitats elsewhere in the Sevier River GMU. Residential development is not occurring as rapidly as it is in the Wasatch Front GMU, but it is still considered a threat. Livestock continue to degrade habitats. The diversion of streams and springs, withdrawal of groundwater, and inundation of reservoirs have altered natural flows and rendered many areas unsuitable for spotted frog. Several nonnative fishes that are potential spotted frog predators, including, but not limited to, rainbow trout, brown trout, brook trout, and largemouth bass, have been introduced into many potential spotted frog habitats. Efforts to remove these species would be necessary prior to any spotted frog introduction efforts.

Population Trends

The San Pitch River population has been monitored since 1992 (Figure 11). In 1992, 54 egg masses were observed at standard monitoring sites. In 2000, 22 egg masses were observed at the same sites. However, surveys conducted in 1999 and 2000 discovered 17 additional breeding sites. In 2000, 115 additional egg masses were found at these sites. The total number of egg masses observed in 2000 was 137. Therefore, the population in this subunit is larger than was previously suspected.

BEAR RIVER GEOGRAPHIC MANAGEMENT UNIT

GMU Description

The Bear River GMU includes five subunits (Table 1, Figure 1). There are no historic records of spotted frog in this GMU. A single report of spotted frog occurrence was provided in 1994 (Gloria Wurst, personal communication). However, subsequent surveys failed to observe any spotted frogs at the site of the report (Thompson and Schmitz 1998, Thompson 1999). Direct threats cannot be described because no spotted frog populations are known to occur in this GMU. However, the threats to potential habitat are the same as those found in other GMUs, and include residential development, livestock impacts, and nonnative species.

Conservation Actions

Surveys are currently the only required action in this GMU. Since 1998, the site where spotted frogs were reportedly found in 1994, and numerous other wetlands have been surveyed (Thompson and Schmitz 1998, Thompson 1999). No spotted frogs have been observed.

OTHER STATEWIDE ACTIONS

Genetic Analysis:

Genetic analysis is required to quantify spotted frog population genetic structure. The SFCAS also requires the development of protocols for range expansion that are based on maintaining the genetic integrity and maximizing the genetic diversity of the species. Prior to 2000, Utah State University completed a population genetic study to determine levels of within- and among-population genetic variability for all known spotted frog populations in Utah (Toline and Seitz 1999).

In 2000, BYU completed a phylogeographic study of spotted frog populations in Washington, Oregon, Idaho, and Montana, as well as all known peripherally isolated populations in Utah, Nevada, and Wyoming (Bos and Sites 2001). The objectives of the study were to: 1) distinguish between demographic and historical factors that contributed to observed population genetic structure; and 2) identify candidate lineages for recognition as Evolutionary Significant Units (ESUs) based on criteria proposed by (Moritz 1994). Analysis of sequences from the mitochondrial cytochrome b gene revealed four geographically correlated monophyletic clades. The Rocky Mountain clade included populations in Idaho, Montana, Oregon, Washington, and Wyoming. The Lahontan clade included 11 populations in Nevada, and the Bonneville clade included 12 populations in Utah. The Deep Creek clade included only the Ibapah Valley population in Utah and Nevada. These results indicate that the Ibapah Valley population possesses an evolutionary history that is distinct from all other populations, and therefore, should be managed as separate unit. The analysis also indicated that significant structure among the four clades was due to historical fragmentation and subsequent allopatric isolation. Each of these four clades was proposed for ESU candidate status, but additional research will be necessary to finalize these designations. The genetic relationships observed in the Bonneville clade are consistent with a pattern of recent eastward range expansion along the receding shoreline of Lake Bonneville, from source populations in West Desert refugia. The study also revealed that genetic diversity was lower in the Bonneville clade

compared to the Rocky Mountain, Lahontan, and Deep Creek clades, suggesting that the Bonneville clade experienced a severe historic population bottleneck. However, additional research will be necessary to confirm this hypothesis.

Research:

The SFCAS requires research to determine spotted frog habitat and life-history requirements. Studies initiated prior to the development of the SFCAS include those by Ammon and Wilson (2000), Perkins and Lentsch (1998b), Ross and Peterson (1998), Hovingh (1993), and Cuellar (1992).

In 2000, USU initiated a study to investigate habitat associations of spotted frog throughout Utah. Habitat used by spotted frogs will be compared to the distribution of available habitat to identify features that may universally limit or benefit spotted frog survival and reproduction. The analysis will be conducted at four spatial scales and comparisons among GMUs will be made to identify any regional differences in habitat preferences. This study will expand on the work of Perkins and Lentsch (1998b) that quantified spotted frog habitat use in Heber Valley. Additional parameters will be examined (e.g. water chemistry), and habitat parameters and use by spotted frog will be characterized in several areas, including the Mona spring complex, San Pitch River subunit, Tule Valley, and Heber Valley. Habitat use during the winter will also be examined through radio telemetry to help define hibernacula requirements. The results of this study will provide guidelines for enhancement and range expansion activities. This study is funded by BOR.

Nonnative Species Control:

UDWR followed the Policy for Fish Stocking and Transfer Procedures (UDWR 1997b). This policy includes specific protocols for the introduction of nonnative species into Utah waters. Under this policy, all stocking actions are to be consistent with ongoing recovery and conservation actions for Utah Sensitive Species.

Range Expansion:

URMCC, UDWR, FWS, BLM, and the U.S. Department of the Interior - Office of the Secretary continued efforts to develop a sportfish and native species warm water hatchery. The proposed hatchery will include facilities to develop and maintain spotted frog genetic refugia. The proposed site for the facility is Gandy Warm Springs in the Snake Valley subunit. URMCC and cooperating agencies initiated the National Environmental Policy Act analysis in 2000.

Mitigation:

Mitigation is required for projects that negatively affect spotted frog. Mitigation needs should be assessed on a case-by-case basis. URMCC acquired a portion of the Mona spring complex in 1998 as mitigation for anticipated wetland impacts from completion of the Central Utah Project. A portion of the 22 wetlands created in Heber Valley in 1999 as part of the PRRP were for mitigation impacts due to PRRP, whereas the majority of the created wetlands were enhancements of spotted frog habitats.

Regulation:

The SFCAS requires the maintenance and enforcement of regulations that prohibit the collection, importation, and possession of spotted frogs in Utah. The collection and possession restrictions protect the species against population depletion due to harvest for commercial, scientific, recreational, or educational use. The importation restriction prevents the importation of spotted frogs that, if released, could introduce harmful pathogens or compromise the genetic structure of the native populations. These regulations have been maintained and enforced in accordance with State of Utah Rule 657-3 (1995).

ASSESSMENT

To direct the effective conservation of spotted frog, the SFCAS requires the implementation of nine classes of conservation actions. Some of these actions have been completed, some actions have been initiated and are ongoing, and other actions have not yet been initiated (Table 3). Years of preparation have been necessary to develop certain protection strategies, and their implementation will be initiated in 2001.

Several threats to spotted frog have been significantly reduced. Habitat acquisition and enhancement at the Mona spring complex has protected a portion of the habitat from development, reduced livestock impacts, and improved habitat conditions. Nonnative species control efforts have also temporarily reduced the threats posed by nonnative fishes in the Mona spring complex. The acquisition of property along the Provo River corridor has protected spotted frog habitat from potential development. The creation of new wetlands in Heber Valley has significantly increased the amount of spotted frog habitat in that area. Egg masses have been observed in these wetlands, indicating that suitable spotted frog habitat has been created. At Miller Spring, the amount of breeding habitat was increased, the exclusion of livestock has improved habitat conditions, and the removal of rainbow trout has eliminated the risk of predation. Spotted frog habitats in Gandy Salt Marsh and Tule Valley have also been protected against livestock impacts through the maintenance of livestock exclosures. Implementation of the habitat management plan for the San Pitch River subunit will eliminate or significantly reduce threats in that area. However, significant threats persist in other spotted frog habitats. Water diversion and livestock grazing threaten the population at Bishop Springs. Livestock grazing, nonnative species, and the risk of development continue to threaten spotted frog in other areas along the Wasatch Front.

Despite some persistent threats, the numbers of observed egg masses for most of the Wasatch Front populations have increased or have been stable since monitoring began. The number of egg masses observed in the Utah Lake subunit has increased at monitoring sites since 1992 and the discovery of additional breeding sites revealed that the population was larger than suspected. The Spanish Fork River observed egg mass numbers have also increased since 1992 and the discovery of additional breeding sites have further expanded the estimates of population sizes. The number of egg masses observed in the Provo River subunit has also increased significantly.

In the West Desert GMU, observed egg mass numbers at Miller Spring/Leland Harris Springs has increased and the Gandy Salt Marsh reproductive output has been generally stable. Although the numbers of egg masses are down since monitoring began, the reproductive output at Bishop Springs has been stable for three years. In Tule Valley, the number of egg masses observed at Coyote Spring has increased and the number of egg masses observed at Willow Spring has been generally stable. Although the number of egg masses observed recently at North Tule Springs are below the initial level, the population currently appears to be stable. South Tule Springs egg mass numbers have been consistently low, but no egg masses were observed in 2000. The number of egg masses observed in Ibapah Valley in 2000 was smaller than in previous years, but this difference does not necessarily indicate a population decline. Instead, it probably reflects a lack of suitable breeding habitat in 2000 due to recent modification of irrigation practices.

The number of egg masses observed at standard monitoring sites in the San Pitch River subunit in the Sevier River GMU has declined since 1992. However, recent surveys discovered additional breeding sites containing egg masses that, in 2000, more than doubled the number of egg masses observed in 1992.

Recent genetic analysis (Bos and Sites 2001) indicated that the Ibapah Valley population has an evolutionary history that is distinct from all other populations throughout the range. The unique genetic composition of this population magnifies the importance of preventing negative impacts to spotted frog in this subunit. Any threats to this population, particularly changes in irrigation practices, should be eliminated as quickly as possible. Relatively low levels of genetic variability within the other Utah populations suggest that there may be limited capability for populations to adapt to changing environmental conditions. Therefore, providing and maintaining suitable conditions in currently occupied habitats assumes elevated importance.

In summary, many conservation actions have been implemented since the SFCAS was developed in 1998. Several threats have been significantly reduced and the numbers of egg masses observed per year have increased for several populations. Based on these results, the SFCAS has been an effective mechanism to guide spotted frog conservation. However, some significant threats persist and certain populations remain small. These factors, combined with recent information about population genetic structure, warrant the implementation of additional actions for the conservation of spotted frog.

FUTURE ACTIONS

Additional surveys will be conducted within priority subunits in each GMU. Surveys to identify additional spotted frog populations and potential habitat in the Lower Weber River and Spanish Fork River subunits in the Wasatch Front GMU, in the southern area of the San Pitch River subunit in the Sevier River GMU, and in Skull Valley and Tooele Valley in the West Desert GMU are currently the highest priority.

A range expansion plan that outlines protocols and needs for brood stocks, genetic refugia, and re-introductions will be developed. The plan will include guidelines to maintain the genetic variability and integrity of the species, guidelines to identify suitable sites for range expansion, protocols for disease treatment, and a list of potential transfer sites.

Additional habitat protection and enhancement projects will be conducted in the Wasatch Front GMU. Several projects are anticipated for the Mona spring complex: A habitat management plan will be developed; The feasibility of dredging late successional springheads to increase habitat size will be assessed; Regulatory signs, boundary signs, and a gate will be installed; Negotiations to acquire additional properties surrounding the spring complex will continue. Habitat enhancement actions will also be implemented in the Spanish Fork River subunit, in accordance with a habitat management plan that will be developed.

Additional habitat enhancement projects are scheduled to occur in the West Desert GMU. In Snake Valley, a rotational grazing system near Miller Spring will be implemented when the pasture fencing is completed in 2001. Negotiations to acquire the water rights for Foote Reservoir and Twin Springs will be initiated in 2001. Acquisition of these water rights would ensure permanent flows to spotted frog and least chub habitat in Bishop Springs. Negotiations to secure water for Ibapah Valley breeding sites will also be conducted in 2001. Options to increase the amount of breeding habitat in the Tule Valley subunit will also be explored.
In the Sevier River GMU, implementation of the habitat management plan for the San Pitch River subunit will be initiated in 2001. Funding has already been secured for the potential purchase of conservation easements, control of nonnative species, and the reduction of livestock impacts. Additional habitat and enhancement projects in all GMUs will be implemented as other potential spotted frog habitats are identified.

Nonnative species control will be implemented. The response of nonnative fish, spotted frog, and least chub populations in the Mona spring complex following the 2000 removal project will be monitored in 2001. If mechanical removal is considered to be effective at reducing the nonnative fish populations, the project will be repeated in fall 2001. If mechanical removal is not effective, alternative methods for nonnative species control will be explored. Options for nonnative species control in the San Pitch River subunit will be implemented in accordance with the habitat management plan. As other potential spotted frog habitats are identified, additional nonnative species control efforts will be implemented in all GMUs, as necessary.

Efforts to construct a warm water hatchery for sportfish and native species, including spotted frog, will continue. Other range expansion actions in each GMU will be conducted according to the protocols and plan for range expansion that will be developed.

UDWR will continue to annually monitor all current and additional populations as they are discovered or established. Mitigation will be conducted for future projects that impact spotted frog habitat, as necessary. Finally, the regulations prohibiting collection, importation, and possession of spotted frog in Utah will be

maintained in the revision of State of Utah Rule 657-3 in 2001.

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Table 1. Subunits, hydrologic unit codes (USGS 1974), and spotted frog distribution (H = historic population; E = extant population) in each Geographic Management Unit.

GEOGRAPHIC MANAGEMENT UNIT	Subunit	Hydrologic Unit Code (USGS 1974)	Spotted Frog Distribution
Wasatch Front	Upper Weber River	16020101	H
	Lower Weber River	16020102	
	Utah Lake	16020201	E
	Spanish Fork River	16020202	E
	Provo River	16020203	E
	Jordan River	16020204	H
West Desert	Snake Valley	16020301	E
	Pine Valley Wash	16020302	
	Tule Valley	16020303	E
	Tooele Valley	16020304	
	Skull Valley	16020305	
	Ibapah Valley	16020306	E
	West Great Salt Lake	16020308	
	North Great Salt Lake	16020309	
	Great Salt Lake	16020310	
Sevier River	Upper Sevier River	16030001	
	East Fork Sevier River	16030002	
	Middle Sevier River	16030003	
	San Pitch River	16030004	E
	Lower Sevier River	16030005	
	Escalante Desert	16030006	
	Upper Beaver River	16030007	
	Lower Beaver River	16030008	
	Sevier Lake	16030009	
Bear River	Upper Bear River	16010101	
	Bear Lake	16010201	
	Middle Bear River	16010202	
	Logan River	16010203	
	Lower Bear River	16010204	

Table 2. Number of spotted frog egg masses and presence of tadpoles observed in 2000 in ten of the 22 wetlands created in association with the Provo River Restoration Project.

Created Wetland	**# Egg Masses in 2000**	**Tadpoles Observed in 2000**
Walker Pond 1	1	No
Walker Pond 2	10	No
Walker Pond 3	15	Yes
Walker Pond 4	4	Yes
Walker Pond 5	8	Yes
Trail Pond	6	Yes
Chad's Pond 1	8	Yes
Chad's Pond 2	2	Yes
Chad's Pond 3	4	Yes
French Drain Pond	6	Yes
Total	*64*	

Table 3. Status of conservation actions (R = required; C = completed; I = initiated and ongoing) in subunits in each Geographic Management Unit.

GEOGRAPHIC MANAGEMENT UNIT	Subunit	Surveys	Research	Genetic Analysis	Habitat Protection/ Enhancement	Nonnative Species Control	Range Expansion	Monitoring	Mitigation	Regulations
Wasatch Front	Upper Weber River	R / I			R	R	R			
	Lower Weber River	R / I			R	R	R			
	Utah Lake	R / I	I	R / C	R / I	R / I	R	R / I		
	Spanish Fork River	R / I		R / C	R	R	R	R / I		
	Provo River	R / I	I	R / C	R / I	R	R / I	R / I		
	Jordan River	R			R	R	R			
West Desert	Snake Valley	R		R / C	R / I	R / I	R	R / I		
	Pine Valley Wash	R								
	Tule Valley	R / C	I	R / C	R	R	R	R / I		
	Tooele Valley	R				R				
	Skull Valley	R				R				
	Ibapah Valley	R		R / C	R	R	R	R / I		
	West Great Salt Lake	R / I				R				
	North Great Salt Lake	R				R				
	Great Salt Lake	R								
Sevier River	Upper Sevier River	R				R				
	East Fork Sevier River	R				R				
	Middle Sevier River	R				R				
	San Pitch River	R / I	I	R / C	R / I	R	R	R / I		
	Lower Sevier River	R / I				R				
	Escalante Desert	R				R				
	Upper Beaver River	R				R				
	Lower Beaver River	R				R				
	Sevier Lake	R				R				
Bear River	Upper Bear River	R / I								
	Middle Bear River	R / I								
	Bear Lake	R								
	Logan River	R / I								
	Lower Bear River	R / I								
Statewide			R / I	R		R / I	R / I		R / I	R / C

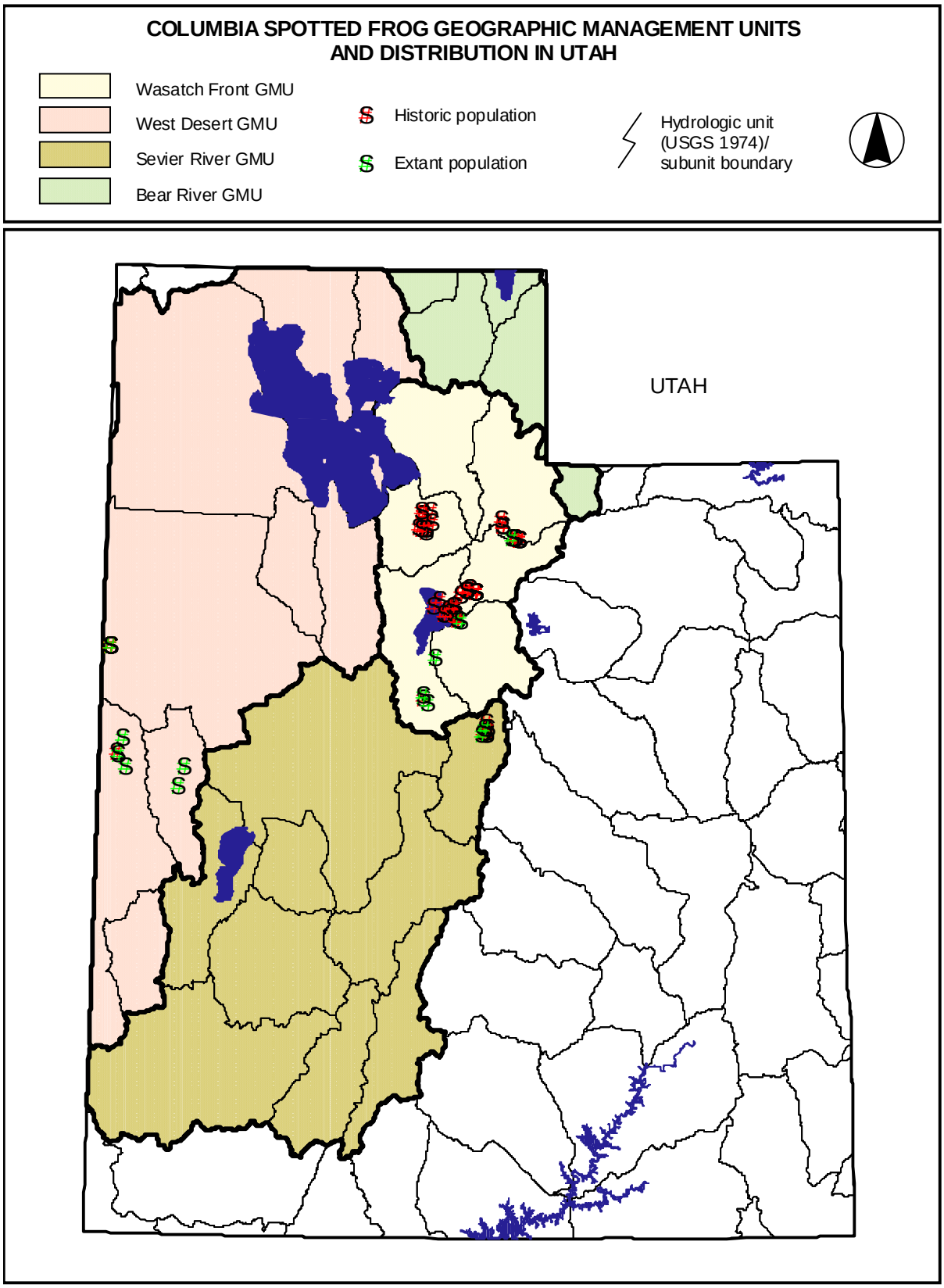

Figure 1. Geographic Management Unit and subunit (USGS 1974) boundaries and locations of historic and extant Columbia spotted frog populations in Utah.

Photos by K. Wilson

Figure 2. Site 5 in the Mona spring complex before and after habitat enhancement projects in 2000. The exclusion of livestock has improved bank condition and increased the amount of riparian vegetation.

Photos by K. Wilson

Figure 3. Vegetation near Site 5 in the Mona spring complex before and after habitat enhancement projects in 2000. The bottom photo illustrates the difference in vegetation levels between the grazed and ungrazed areas.

Photos by K. Wilson

Figure 4. Miller Spring before and after livestock exclusion in 2000. The exclusion of livestock has improved bank condition and increased the amount of riparian vegetation.

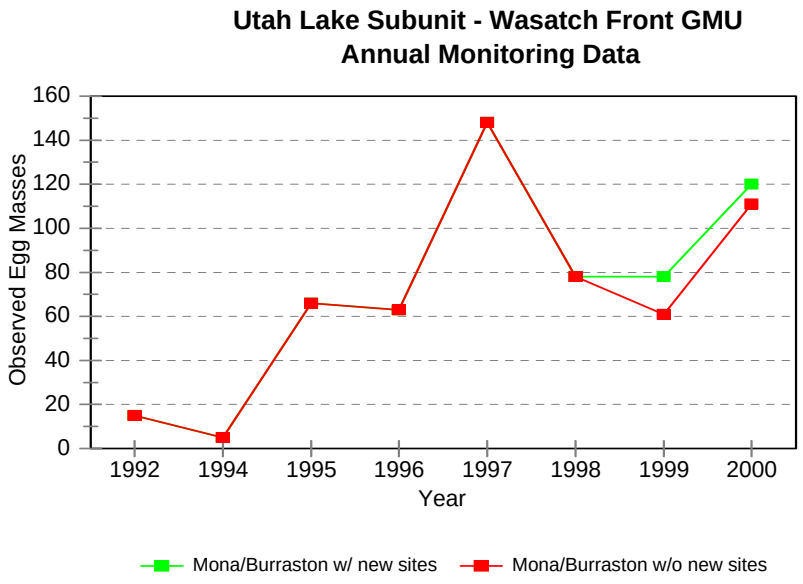

Figure 5. Number of egg masses observed in the Utah Lake subunit in the Wasatch Front GMU during annual population monitoring from 1992 to 2000. The green line represents egg mass numbers for both standard monitoring sites and additional breeding sites discovered in 1999.

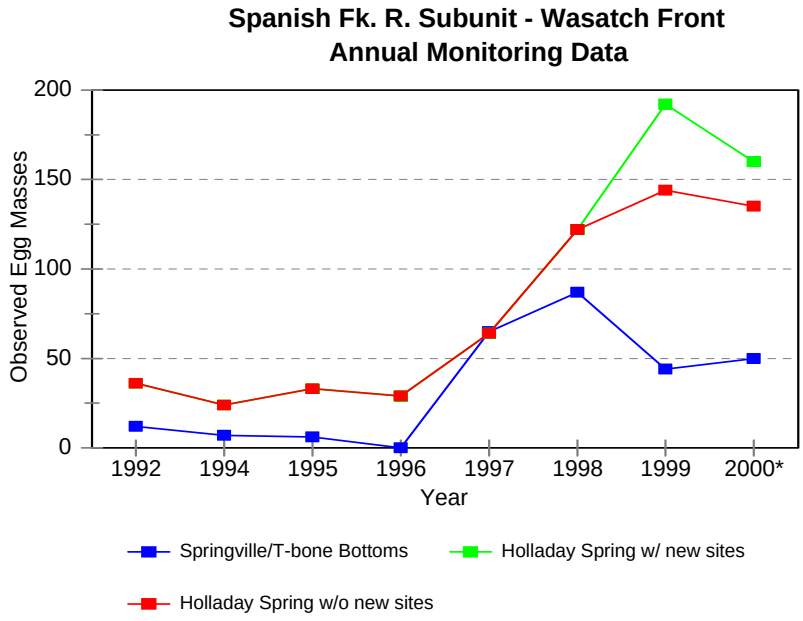

Figure 6. Number of egg masses observed in the Spanish Fork River subunit in the Wasatch Front GMU during annual population monitoring from 1992 to 2000. The green line represents egg mass numbers for both standard monitoring sites and additional breeding sites discovered in 1999 at Holladay Spring. * T-bone Bottoms was not monitored in 2000.

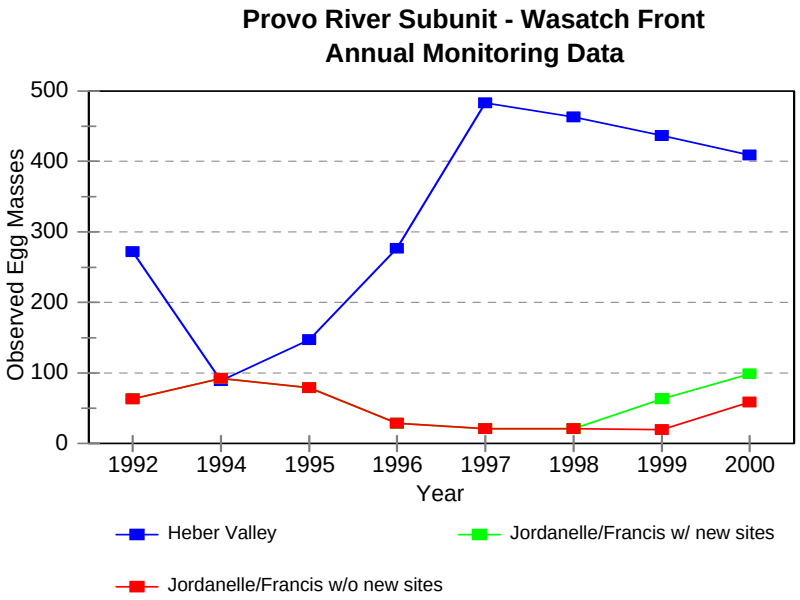

Figure 7. Number of egg masses observed in the Provo River subunit in the Wasatch Front GMU during annual population monitoring from 1992 to 2000. The green line represents egg mass numbers for both standard monitoring sites and additional breeding sites discovered in 1999 at Jordanelle/Francis.

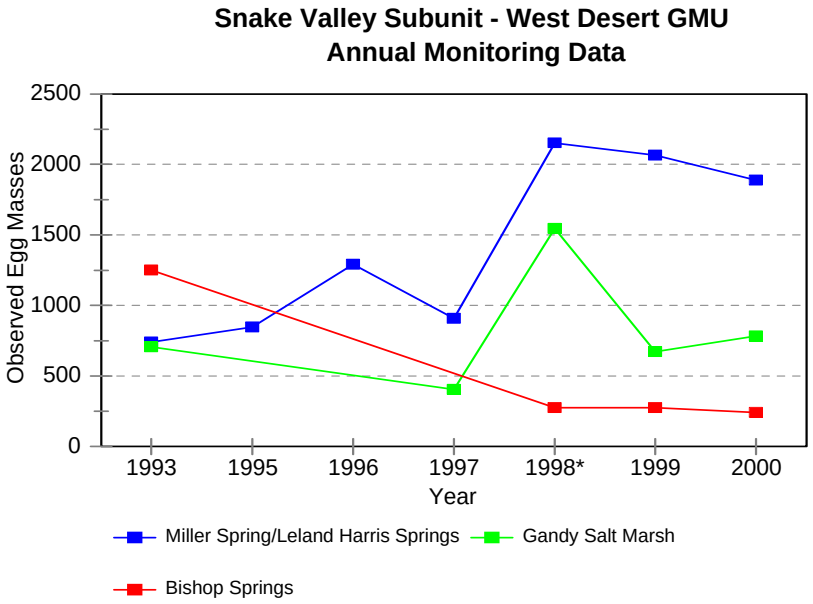

Figure 8. Number of egg masses observed in the Snake Valley subunit in the West Desert GMU during annual population monitoring from 1993 to 2000. ***** Monitoring sites were modified at Miller Springs/Leland Harris Springs and data may not be comparable with those for previous years.

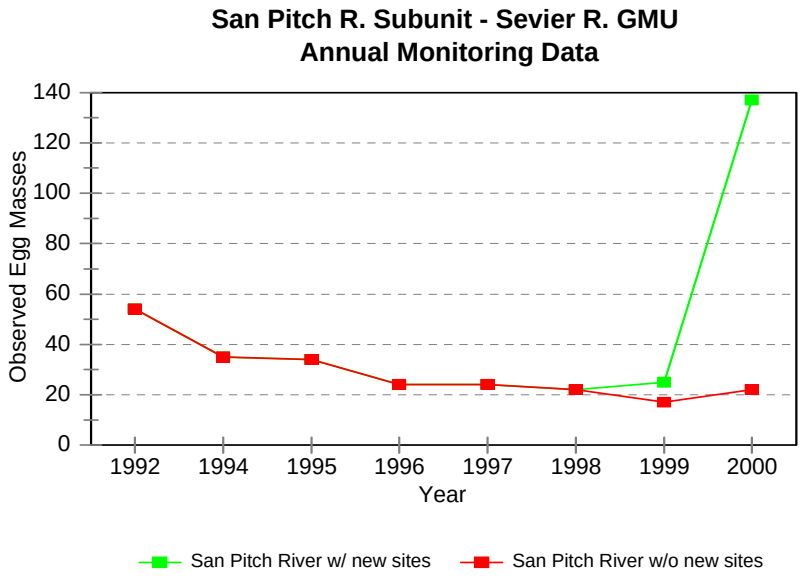

Figure 9.
Number of egg masses observed in the Tule Valley subunit in the West Desert GMU during annual population monitoring from 1993 to 2000.

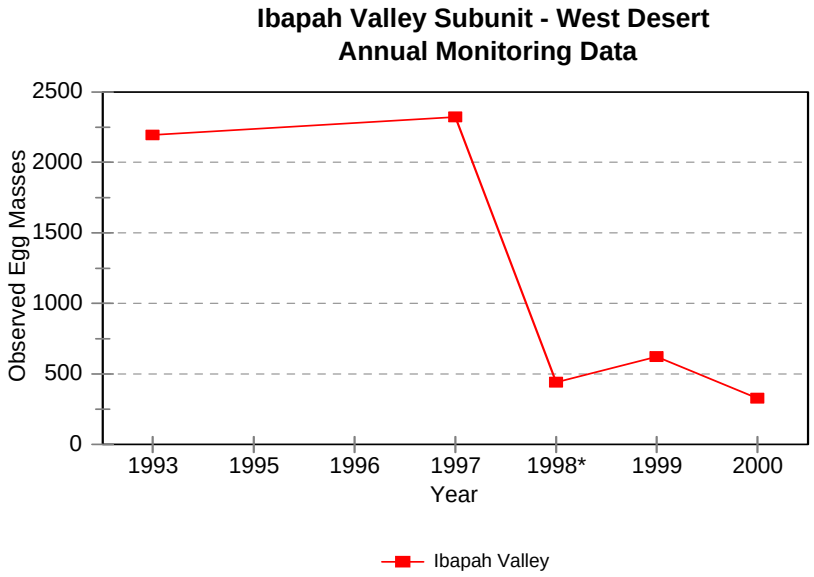

Figure 10. Number of egg masses observed in the Ibapah Valley subunit in the West Desert GMU during annual population monitoring from 1993 to 2000. * Monitoring sites were modified and data are not comparable with those for previous years.

Figure 11. Number of egg masses observed in the San Pitch River subunit in the Sevier River GMU during annual population monitoring from 1992 to 2000. The green line represents egg mass numbers for both standard monitoring sites and additional breeding sites discovered in 1999.